HARDCORE

PERCUSSION FLAKING PALEOLITHIC STONE TOOLS FOR THE COMPLETE BEGINNER

By Nathan Martinez

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Basics

This tools and techniques presented in this guide are organized according to the date at which they first appear in the archaeological record, which also tends to correlate with procedural complexity. However, there are a few important properties of stone and principles of knapping to be aware of that are applicable to all stages of stone tool production.

It should be noted that later techniques did not necessarily negate earlier ones – new techniques were built on and added to the existing catalog, and techniques and tools developed in the Paleolithic persisted unbroken in a few indigenous cultures well into the 20th century.

Nodule

Many glass-like stones can be used for knapping, such as **obsidian**, **jasper** and **chalcedony**, and even **basalt** and **quartz**. However, for the beginning percussion flaker, I recommend starting out with **chert** or **flint**. While material such as obsidian requires less force to remove large flakes, its fragility and the sharpness of its flakes can be unforgiving to a misplaced or overly forceful blow.

Chert and flint (fine-grained chert with a waxy sheen) are naturally found with sedimentary stone such as chalk and limestone. It typically occurs in **nodules**, or masses encased in a thin skin or **cortex** of sedimentary rock. This cortex can make stone identification somewhat difficult, but the cortex is sometimes pitted or chipped, which can reveal the chert within.

The nodules also tend to be heavier than surrounding non-chert-containing rocks of the same size. Prior to carting back buckets of stones, it is a good idea to chip off a corner or edge to check the contents and flaking characteristics. The stone should produce a sizeable flake without crumbling or too much force required. The flake should also be checked to ensure that there are few embedded cavities or **inclusions** (impurities).

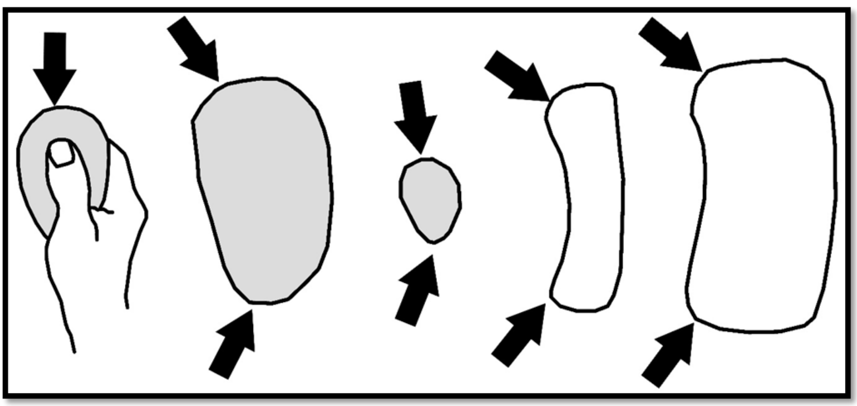
Hammers & Billets

The stone that will be used to strike the chert nodule is referred to as a **hammer stone**. The stone should be sturdy enough so that it will not crumble or break, and its surface should be either slightly rough or soft enough to avoid slippage when making impact. This rock can be hard limestone, quartzite or even a smaller chert nodule. The shape and weight of the hammer stone will affect the length and width of the flakes produced with it.

For all but the largest nodules, I try to begin with an egg-shaped hammer stone with about the same volume and width as a baseball. A stone hammer that is longer will provide more leverage and longer flakes but could snap in half. On the other hand, a hammer that is more spherical is less likely to break but will be difficult to hold without occasionally smashing one's fingers. For fine finishing touches that require shorter, thinner flakes, I use either a smaller hammer stone or a side of a larger hammer stone that has less surface area (i.e. the pointed end of an egg).

During the Mousterian, some knappers began to use softer **billets** made from dense wood or antler, allowing for flakes to be struck with more precision and control. A billet is typically about as long as a hand and one to three inches or so thick. Because they are not as dense as stone hammers, they must be moving at greater speed to obtain large flakes. However, their length serves to somewhat negate this drawback through the leverage of centrifugal force. Another drawback of the soft billet is that the business end tends to quickly flatten with heavy use, diffusing the point of impact.

To remain effective, the billet must be ground round. Typically, I use antler billets only in the final stages of making upper Paleolithic **bifacial** (flaked on two sides) knives and points, or when working with obsidian. For all other tools, I greatly prefer to employ an array of hammer stones of different sizes and shapes.



Three hammer stones and two antler billets. The arrows show the ideal points of impact.

Posture

The majority of knappers today sit on a chair with their legs apart, resting the nodule on a large piece of leather draped over the non-dominant leg and bracing the nodule from the top with a leather glove. However, the knappers of the lower Paleolithic almost certainly did not have chairs – they would have been squatting, cross-legged or perhaps sitting on a low log or rock. The majority also probably did not use leather pads or gloves. I first observed a difference in knapping posture while watching films of Australian Aboriginal elders percussion flaking while sitting naked directly on the ground.

Above: Australian Aboriginal vs. modern postures

For many years, I made daily trips to a chert outcropping without protective gear, a chair or tools of any kind. I would select a nodule and hammer stone from what I could find, then sit on a low log knocking out Levallois flakes and prismatic blades for hours on end. Without a leather pad, the modern technique of resting the nodule *directly* on a leg risks severing blood vessels with lethal consequences. I solved the problem by resting *my wrist* on my leg and holding the nodule in the palm of my hand.

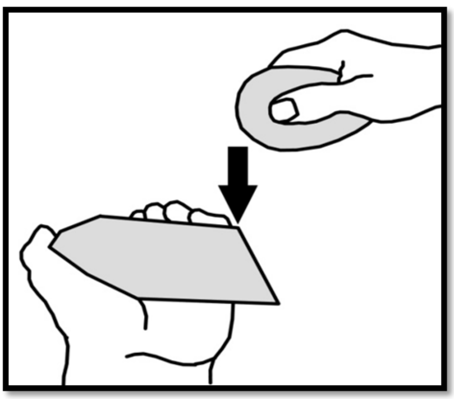
Because I also don’t use gloves, I often get many small cuts on my hands, but in over 20 years of knapping, have only suffered 2 deep cuts to my fingers. Holding the stone in the palm of my hand enables me to feel the ridges, contours and weight of the rock much more keenly. In addition, gripping the stone in my palm also gives me greater control over the angle of impact.

For larger nodules, I use much larger and/or denser hammer stones. When I knap stones that are too heavy for my wrist to support, I rested them either on the ground or a log. These days, even if I knap while sitting in a chair, I still prefer more primitive techniques. While I do recommend the nodule-in-palm technique, I also recommend that beginners wear thin leather gloves and eyeglasses at least until a little experience with knapping is acquired.

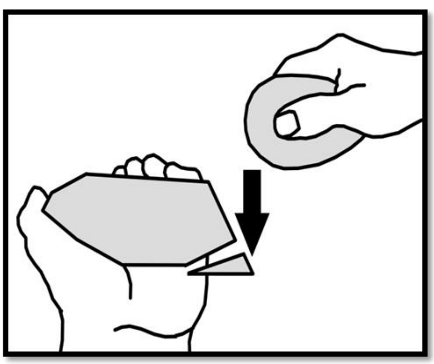
An important point to drive home is to grip the nodule firmly and maintain the angle of impact. Many beginning knappers loosen their grip on the nodule just before the hammer stone makes impact– a mistake that results in shorter flakes, thicker cores and other irritating mistakes. Finally, the blow should go straight down, rather than in a broad arc like a hammer. This way, the only variables are the force of the blow and the angle of the nodule.

Angles

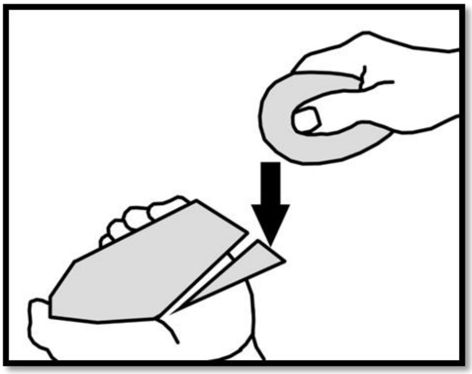
An aspiring knapper will quickly discover that flakes only come off if the angle of the striking edge, or **platform**, of the nodule is 90 degrees or less, and that the orientation of the surface to the blow affects the length of the flake. As a general rule, the more the nodule is tilted downwards, the shorter the flake will be. If it is tilted upwards, the flake will be longer (provided enough force is behind the blow). Lots of hands-on practice will train your brain to intuitively fine-tune these general principles, giving you more control over flake length without conscious awareness.



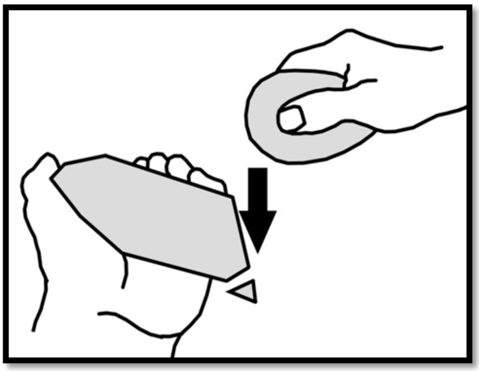
Bad angle: greater than 90 degrees, no flake



Good angle: less than 90 degrees, flake removed



Upward angle: longer flake

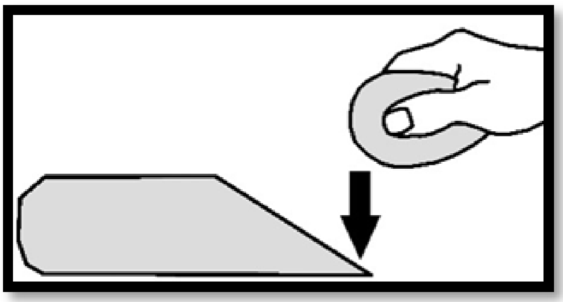


Downward angle: shorter flake

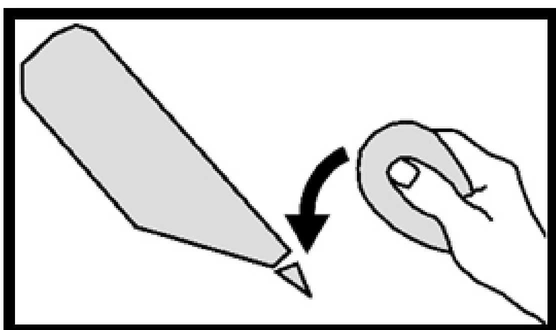
Platform Preparation

The platform is the edge of the nodule that will be hit with the hammer stone. The cortex that covers many nodules can be soft and crumbly, which both dampens the blow of the hammer and produces low-quality flakes. Therefore, to produce useable flakes, at least some of the cortex must be removed. Once work begins on the nodule, we will refer to it as a **core** – an artifact that has been modified.

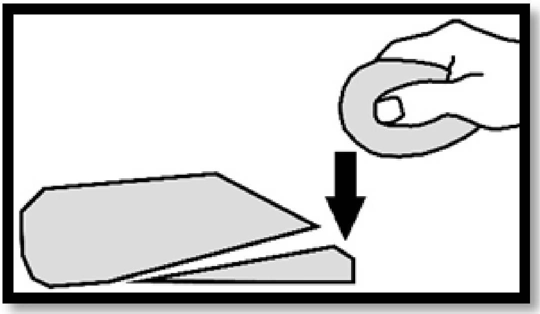
To remove some cortex, you will need to locate an edge of the stone with an angle of 90 degrees or less. Examine the edge to ensure that it is not sharp, as a sharp edge will crumble when struck rather than produce flakes. If the edge is sharp, flip the nodule over, tilt it downward, and with short flicks of the wrist, **abrade** (tap or grind) the sharp edge to dull it. Flip the nodule back to the initial orientation, gripping it in your leg-supported palm. Raise the hammer stone approximately one foot above the platform and strike it with force. The flake will be removed from either the underside or side of the nodule, depending on the orientation of the platform.



Platform edge too sharp

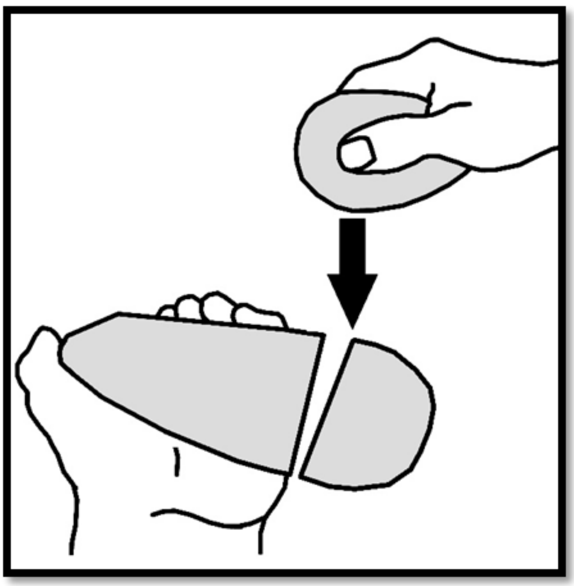


Core flipped & platform edge chipped or abraded

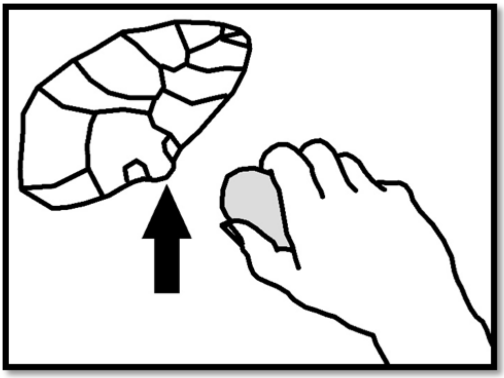


Abraded edge struck, large thick flake removed

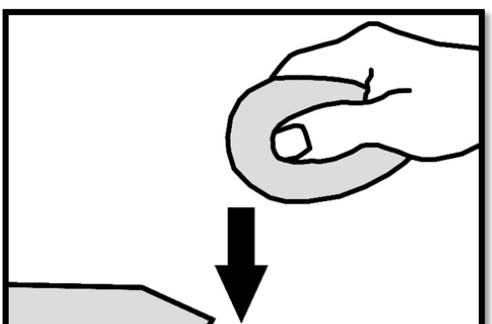
If a suitable edge cannot be located on the nodule, the nodule must be broken or split open. To do this, it must be struck with a heavy hammer stone towards one end with great force. If a hammer stone will not open the rock, you may have more luck with the anvil method – which consists of placing the nodule on a large boulder and smashing it.



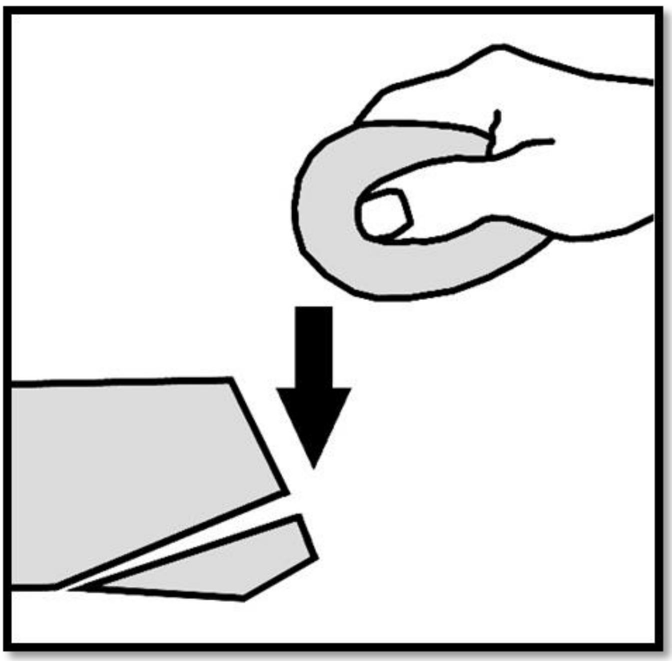
It is important to isolate the platform. This means that the striking spot has no interfering ridges, bumps or projections on either side. Once struck, the flake will be removed from the underside of the core. Once a flake is struck, make sure to remove it and any slivers to avoid cutting your hand any more than neccesary.



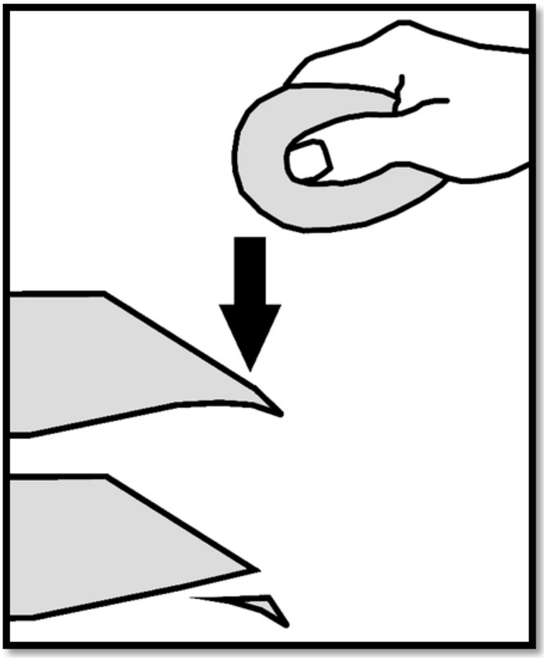
To thin the core, the platform edge must also be lower than an imaginary **center line**. In the illustration below, the edge is *above* the centerline. The flake comes off more towards the side, making the core blockier in shape.



In the illustration below, the platform edge is *below* the centerline. The resulting flake comes off more towards the underside of the core, thinning and flattening it.



When a flake is removed, the surface of the core begins to acquire a “scooped-out” shape. Prior to removing additional large flakes from a scooped-out surface, the sharp curved edges must be smoothed and rounded in the *opposite* direction by removing short flakes from the same surface. This is similar to the platform edge-dulling procedure, but in this case the core is not flipped over. Failure to **remove overhangs** can result in step fractures and square edges, both problematic, whose remedies are described further on.

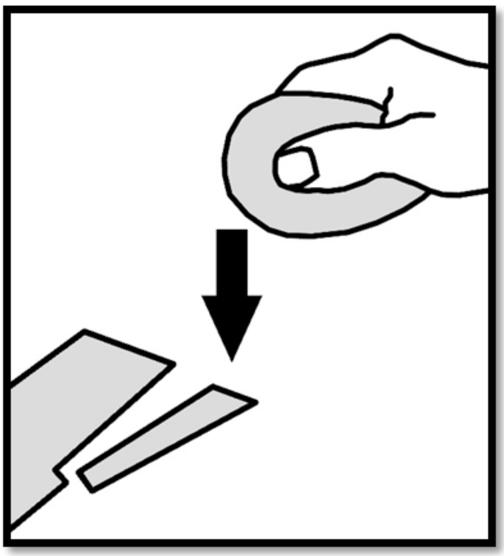


Removing an overhang.

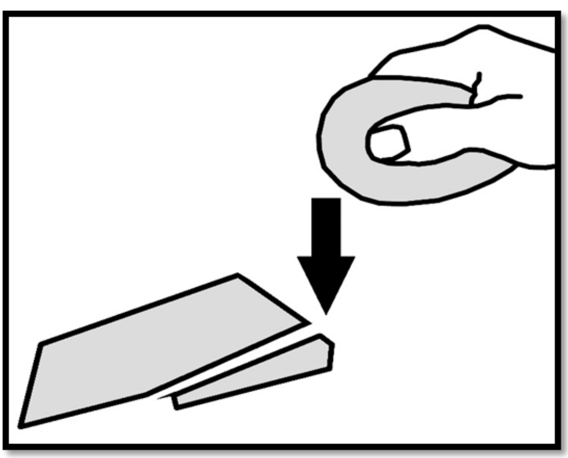
Step Fractures

Step or **hinge fractures** are the result of flakes not travelling all the way to a feathered sharp edge. They are the source of a great deal of frustration to many knappers, but to beginners in particular. Instead of peeling off of the core surface, the flake breaks or rolls in the middle of being removed, leaving a sharp, step-like scar on the core. Typically, attempting to remove more flakes from the same direction only steepens the "step," ultimately rendering the core unworkable. Step fractures are caused by either not striking with enough force, the presence of a flaw or previous crack, holding the core at too high of an angle or allowing a large-scale overhang to form.

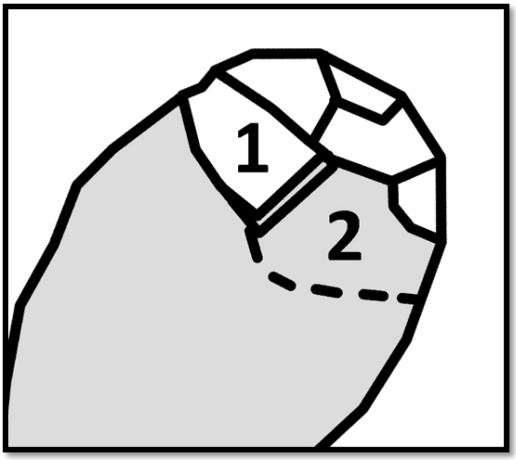
There are two possible ways to remove a step fracture. The first way consists simply of rotating the piece 180 degrees and removing a large flake from the opposite direction, which takes the step with it. Prior to this, make sure that the platform is dull, well-angled and free of overhangs.



Angle too steep, step fracture created.



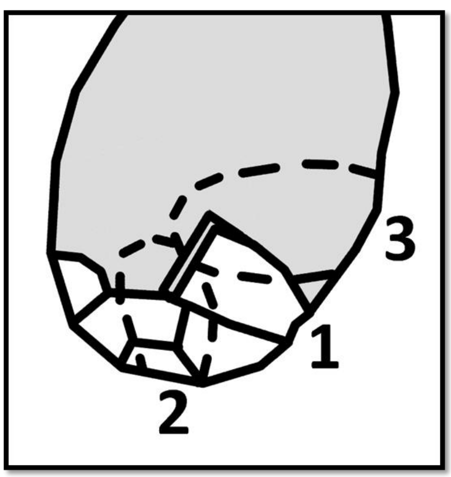
Core rotated, flake removes step from opposite side



Opposite-side step fracture removal technique viewed from above core. Flake 1 created the step fracture, depicted by two parallel lines. Flake 2 (dotted line) should remove the step if it runs far and deep enough.

If the opposite side is too far away from the fracture, an attempt can be made to remove it from the same side of the flake that caused it. Again, make sure that the platform is dull and overhang-free, then rotate the core a little so that the flake travels at a diagonal angle into the step (i.e. don't strike the exact same platform or follow the same path as the problem flake).

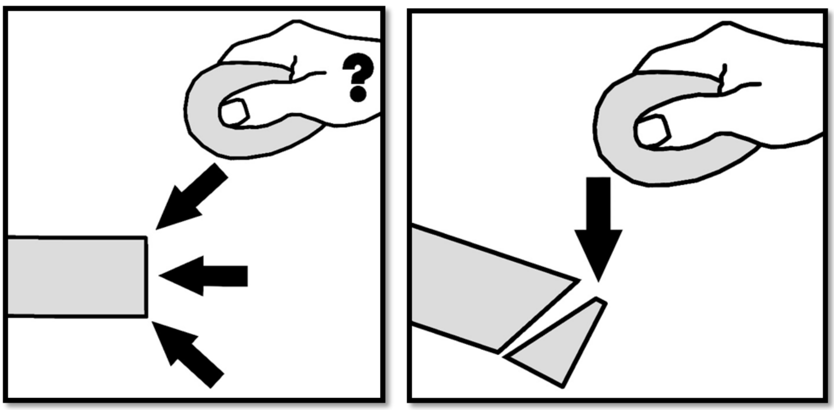
Same-side step-fracture removal. Flake 1 created the step fracture. Flakes 2 and 3 are removed diagonally to flake 1 and each remove half of the step.



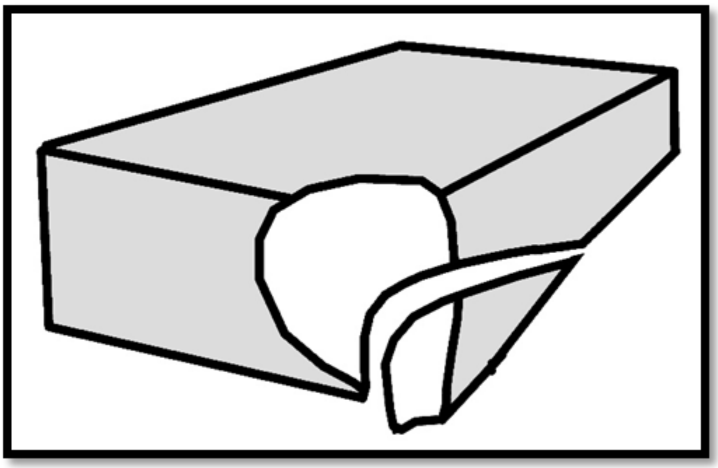
If the above techniques fail, rotate the core in the opposite direction and try from a different path. If this also fails, simply avoid working the problematic side of the core anymore until the core is small enough to try the opposite side method again.

Square Edges

Core edges that are close to 90 degrees can be difficult to deal with for a beginning knapper. The nodule might naturally have square edges, or they could develop during the knapping process. To remove a square edge, simply tilt the core downwards and knock off the corner to create a new inclined platform.



If a square edge is particularly long or problematic, the core can also be rotated a bit to run a flake diagonally, or more along the edge. The core is then flipped upside down, and another diagonal flake removed from the new platform created. The process of flipping and flaking is repeated until the square edge is removed.



Alternate square-edge removal.

Oldowan

2.6 to 1.7 million years BP

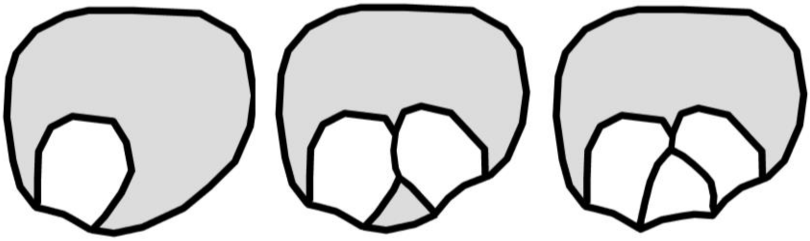
Like chimpanzees, our early ancestors began eating small game in the forests in deep prehistory. As they moved onto the savannahs where small game was harder to obtain, they were forced to focus on bigger game with tougher hides, spurring the production of the first cutting tools – simple flakes and **choppers** such as those found in the Olduvai Gorge. If you have been practicing banging two rocks together while reading over the basics, you have probably already produced some simple Oldowan-level flakes.

Unifacial Core Chopper

Flakes: 2 – 8

Difficulty: Beginner

A chopper is basically a heavy, axe-like tool that can be used to hack through wood and bone. The first choppers were **unifacial**, meaning that they were flaked from only one side without flipping the core back and forth. Making an Oldowan chopper is very simple: take a river cobble and knock off a flake. Move down a bit and knock off another flake. Repeat until a beveled edge the length of the rock side is obtained. During this level, pay careful attention as to how the ridges formed by previous flakes effect the shape and direction of subsequent flakes.



Unifacial Oldowan core chopper

Acheulean

1.7 million years BP to 160,000 BP

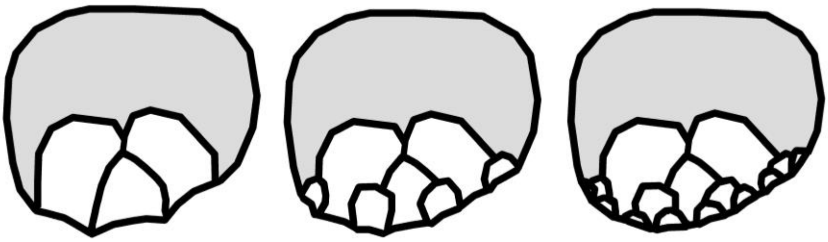
The Acheulean industry emerged as human migrated out of tropical Africa into the colder regions of the Ethiopian highlands, Middle East, Europe and Asia. In these colder environments, the naked apes would not survive without some kind of clothing, and the only option available at the time was the skins of other furry animals. However, they faced a few hurdles to transform skins into clothes. First, the skins rotted and hair fell out if the muscle and fat were left attached. Second, the skins became stiff when dry. To remove the tissue, start opening up the fibers of the skins and break them soft, a new tool was needed. Flakes were too fragile and sharp, and choppers were too heavy and unwieldy.

Scraper

Flakes: 7 – 20

Difficulty: Beginner

A scraper can be made from either a thin flat chopper core or a large thick flake. Like the chopper, the scraper is flaked on only one side. Simply tilt a thin chopper or thick flake downwards, and flick off a series of short flakes along ridges of one edge. On these ridges, flick off another series of even shorter flakes. The short flakes serve to remove the serrations and add a bevel to the edge so that it is both stronger and does not slice through hide.



Hand Axe

Flakes: 12 – 60

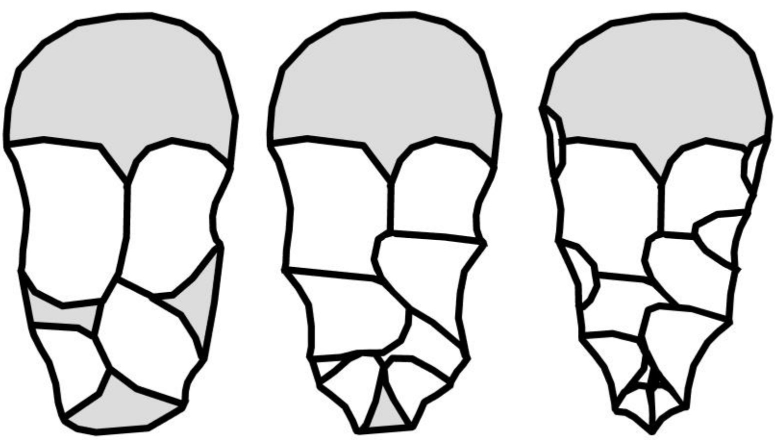
Difficulty: Intermediate

The hand axe is an enigma. We don't know with any real degree of certainty what its purpose was, but there are many theories: a kind of general-purpose "Swiss Army knife", a symbol of intellectual fitness used to woo mates, trade item, digging tool and/or weapon. Whatever the case, the hand axe is present in the archaeological record for hundreds of

thousands of years, growing ever thinner and more symmetrical.

While the triangular or tear-drop shaped form fades out after the Mousterian, the conceptually very similar **preform** or **blank** is found in stone tool assemblages up to the present time. A preform is a bifacial core with most cortex removed – making it lighter for transport and easier to either produce more flake tools or reduce to a bifacial axe, knife or point. It is possible that the first hand axes were simply the product of attempting to "skin" a nodule of cortex, but this does not account for the clearly idealized standardized shapes that later appear.

Making your first hand axe will be much easier if you start out with a nodule that is already somewhat flat and pointed. The initial goal should be to simply remove the cortex and produce two parallel faces. There are two primary methods that can be employed. One, a face of the nodule can be flaked all the way down one edge. The core can then be flipped, the platform tapped or ground dull and lowered, and then flaked on the opposite face. The process is then repeated for the other edge. An alternate method entails flipping the core for *each* flake removal with little or no dulling.



I tend to employ an improvisational intuitive combination of the two that comes with years of knapping experience. Each nodule is different, with its own quirks and irregularities. Rather than try to impose my form on the stone, I attempt to imagine a tool *within* it. I merely try to expose that tool, flipping the stone back and forth and viewing it from many angles before the next blow, looking for the best platforms and ridges that materialize as work progresses.

Mousterian

160,000 to 40,000 BP

As ancestral humans faced periods of global cooling and ice ages, they grew ever more reliant on even larger prey, prompting yet another innovation in stone tool manufacture. In addition to tools for scraping hides, tools were added to the kit to carve spear shafts and serve as razor-sharp cutting points and sturdy knives. As the population grew, humans also likely became more territorial, necessitating the push to conserve valuable finite resources like knappable stone. As a result, techniques began to emerge that attempted to maximize the length of cutting edges and number of sturdy but thin flakes that could be obtained from a single nodule.

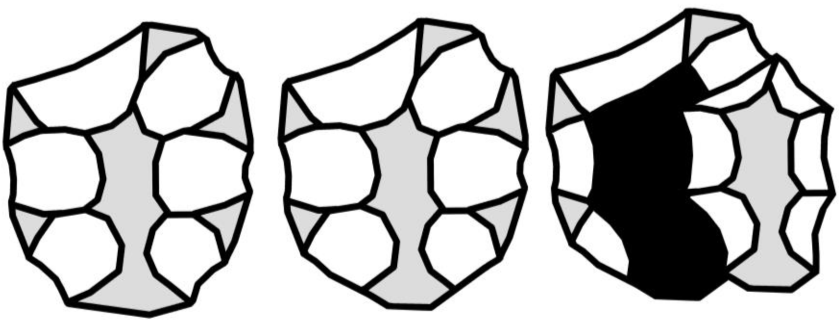
The **Levallois technique** of early anatomically modern humans and Neandertals was a great cognitive leap forward. These ancient humans discovered that carefully preparing cores enabled the production of standardized, razor-sharp flakes, one after another. Instead of providing only a few tools, a single nodule could now make dozens.

Levallois Flake on Centripetal Core

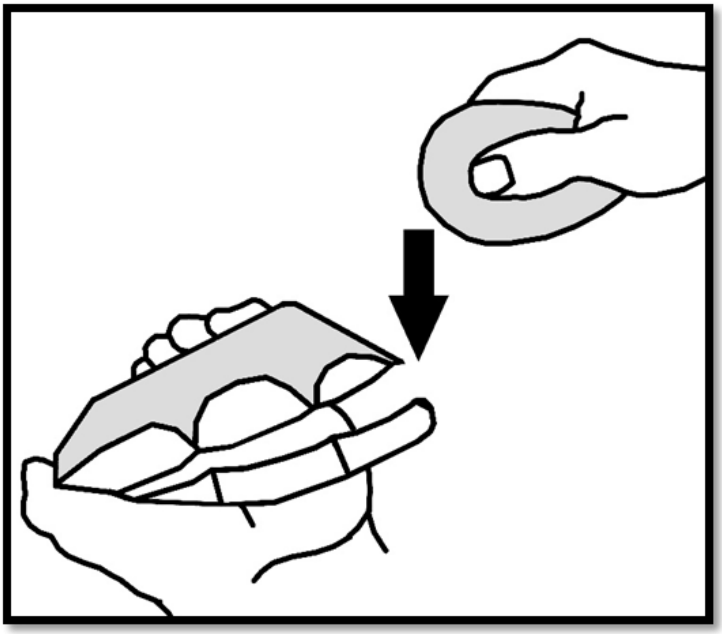
Flakes: 8 – 100's

Difficulty: Intermediate

The first Levallois flakes, which were triangular or trapezoidal in cross section, were likely produced on hand axe cores, or simple thick preforms. However, the Levallois core soon evolved into a more standardized round or oval **turtle** shell shape – inclined on the surface from which flakes were removed, which enabled the flakes to be large and directed with control along a central ridge.



Of greatest importance, once most of the cortex is removed from one face, and that face is rounded, the striking platform must be lowered and isolated. When viewed from above, the platform should consist of a thick nipple-shaped projection.

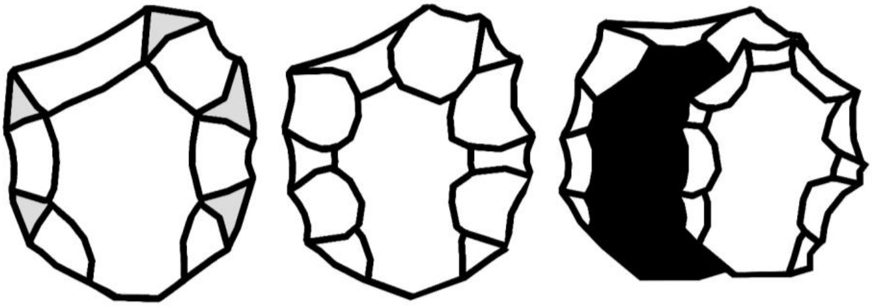


When viewed from the side, the platform of the Levallois turtle core should slope steeply.

From the end, the platform should be “U” shaped, so that the hammer stone has no obstructions on either side. Finally, the blow must be powerful and not too close to the edge of the platform. A blow that is soft or too close to the edge will result in thin short flakes that may not make it to the bevels of the peripheral flakes, or worse, could result in a step fracture. On the other hand, a blow that is too far from the edge could result in splitting the core in half or **overshooting**.

Once the first Levallois flake is removed, a new platform can be prepared beside the previous one, and yet another flake removed in a process called **recurrent centripetal** flaking. In this manner, the platform works its way around the core’s circumference as flake tools are removed in flat stacks. Prior to striking the next Levallois flake, it is important to maintain the central ridge by tilting the core downwards and removing shorter flakes from the circumference if need be.

Archaeologists refer to these often unused and discarded flakes as **debitage**.



Above: A second Levallois flake removed from a trutle core.

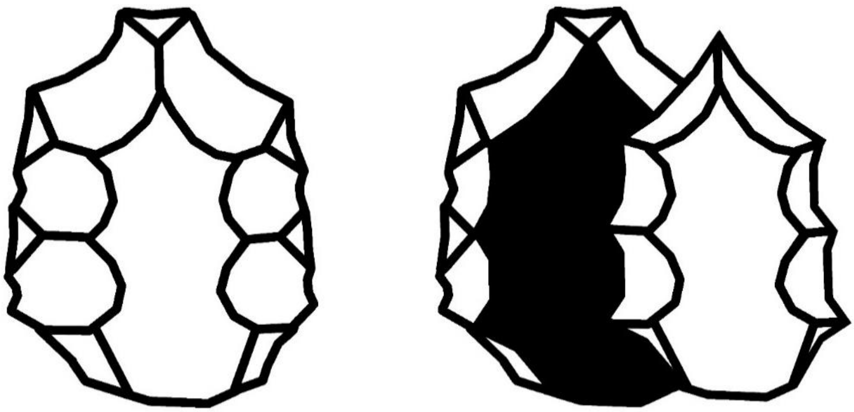
Constructed Levallois Point

Flakes: 5 – 20's

Difficulty: Intermediate

The standard unspecialized Levallois flake tends to be oval or rounded in shape. These blanks could be used as-is as knives, or **retouched** by removing short flakes to make scrapers and points. Eventually, however, a form of point-making began to emerge that required minimal (if any) retouching, resulting in triangular or leaf-shaped points with razor-sharp edges around the entire circumference. The simplest way to make a construction Levallois point is to make a standard turtle core, but instead of oval or round, its general initial shape is more triangular. Once the general shape of the core or face is satisfactory, the platform is lowered and the point struck.

Sometimes, the blow will overshoot, producing a quadrangular, or square-ish flake instead of a pointed one. At other times, the flake will not travel beyond the convergence of the core flake scars and be too thin for use. The key to learning to produce Levallois points is patience, persistence and plenty of raw material. Ideally, the point should be formed by the convergence of flake scars, but it can be difficult to consistently obtain this. When a flake is obtained that is generally in the right shape, a little retouch with a small hammer stone can be used to bring the edges to a point without dulling the razor edges behind it.



Prismatic Blade on Polarized Core

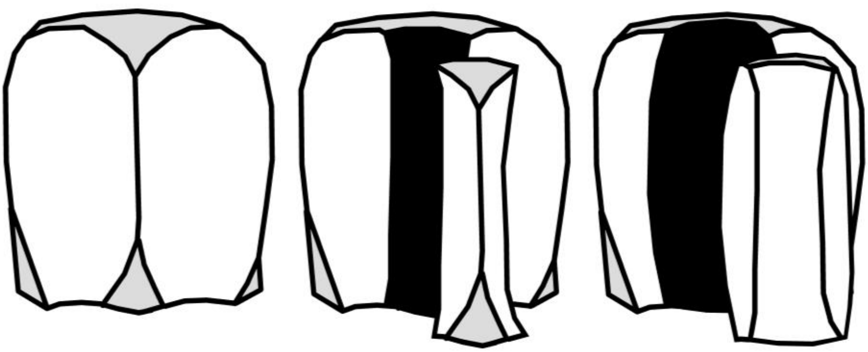
Flakes: 4 – 100's

Difficulty: Intermediate

At some point during the Mousterian, an even more radical innovation in knapping appeared. It was discovered that running flakes parallel to each other on a thick, blocky core could produce one long **blade** after another without having to waste flakes preparing faces and platforms. The blades

produced are **prismatic** in cross section, having 3 or more flat sides. One or more ridges formed by flake scars run parallel along much of the blade length, which serves to reinforce the tool.

Once the cortex is removed from one side of a blocky core, the first flake tool is removed by striking between two ridges, which also serves to create new isolated platforms on either side for the next flakes. Of specific importance is the order of flake removal to maintain a slightly curved face, and the force of the blow to keep flakes peeling off the entire length of the face. If a flake does not make it all the way, the core must be rotated 180 degrees and the bump or step fracture removed. When removing long thin flakes, it is also important to support the face of removal with the hand along as much of their length as possible to prevent them from snapping.



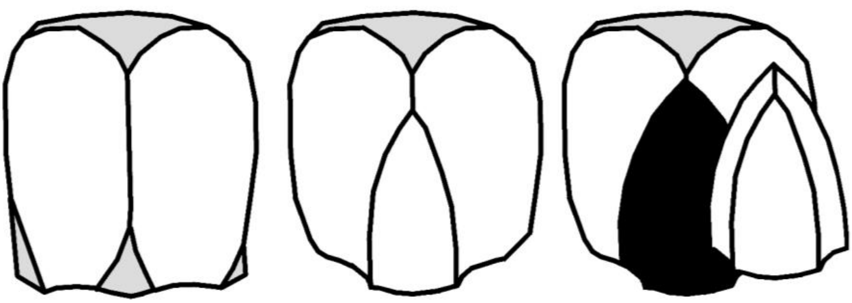
Above: sequence of producing a prismatic flake with trapezoidal cross-section. The flake removed in the middle image can also serve a razor-sharp tool, but has a triangular cross-section with steep sides. After removal of the flake in the last image, the overhangs would be removed and flakes struck off the sides of the core to maintain the curvature of the face.

3-Blow Levallois Point

Flakes: 4

Difficulty: Expert

The 3-blow Levallois point was the pinnacle of Mousterian technology – a symmetrical lance head formed (technically) by 4 blows, leaving 3 flake scars with two razor-sharp beveled cutting edges terminating in a point. The point can be produced on either a bipolar (flaked from opposite directions) or unipolar (flaked from a single direction) core. On either core, care should be taken to ensure main striking platform and flake scars on the face resemble those on the diagrams bellow.



Above: Note that the two intial flakes can be made from either side, or even opposite sides of the core. There are also rare instances where the triangular flake removed in step two is removed *before* one of the long parralel flakes, such as depicted on the cover of this guide.

Upper Paleolithic

50,000 to 12,000 BP

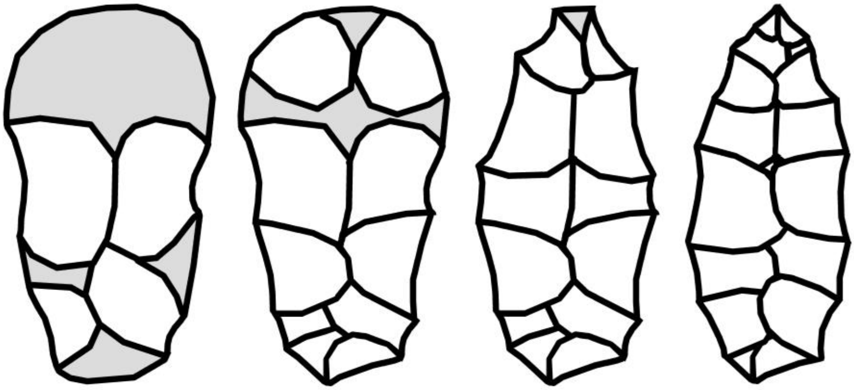
During the bitter cold of the Würm glaciation, Neandertals were outcompeted by anatomically modern humans equipped with long-range projectile weapons – long "darts" tipped with ultra-thin and lightweight stone blades and hurled with spear-throwers. During this era and the subsequent Mesolithic, modern humans perfected the ultimate efficient knapping technique of peeling away blades and blanks from a circular conical or cylindrical core like leaves from a head of lettuce. This technique enabled up to hundreds of tools to be produced from a single core with almost no waste, other than a tiny, scored cone left at the end.

Bifacial Knife

Flakes: approximately 36 – 100's

Difficulty: Expert

Knapping a bifacial knife or point is conceptually very similar to the process of making a hand axe, but the final product is much thinner. If you have mastered the above techniques, you should now be able to run long enough flakes to thin a piece sufficiently. Unlike with a hand axe, the thickest end will become the point. The reason is that although more material must be removed to form the point, the base of the knife must also be very thin to enable **hafting** (inserting it into a handle or shaft). A knife can be made from either a long flattish nodule, or from a thick flake.



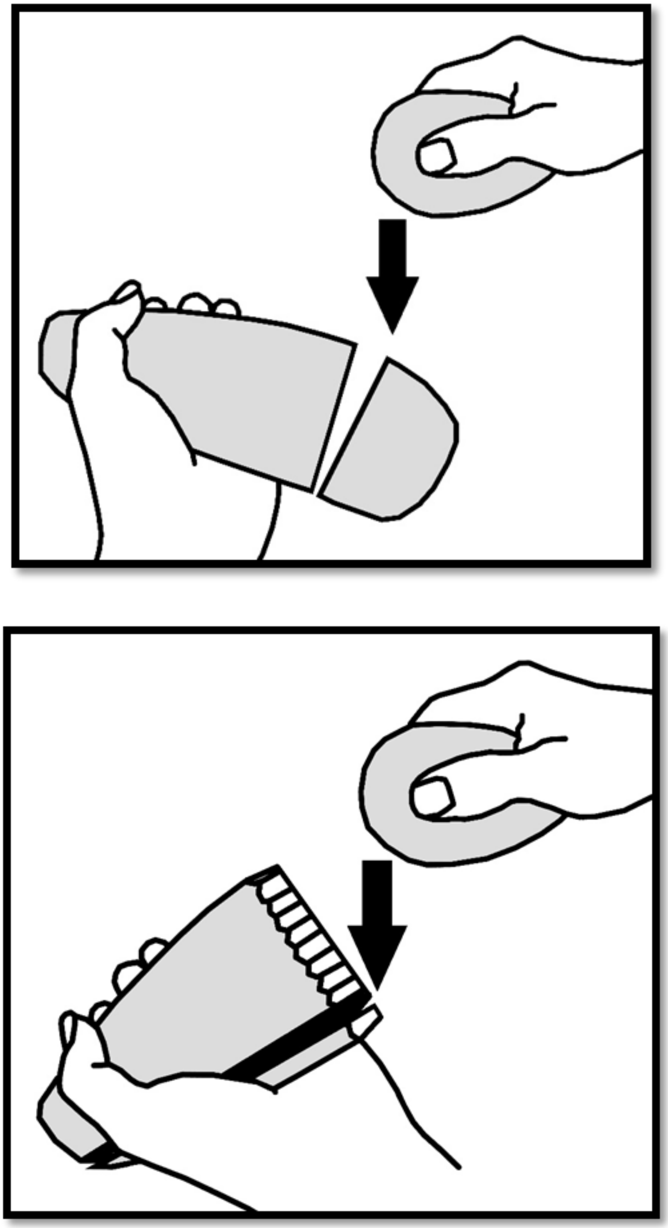
Above: Carefully note the sequence of flake removal between each step. To remove long flakes (making the piece thinner) strike between two ridges formed by previous flakes, like making the prismatic blade. To maintain as much width as possible on the final point, abrade the edges well and strike as close the edge as possible. After the step depicted in the final image, a small hammer stone can be used to run long thin flakes directly down the remaining ridges after they have have been abraded. This serves to sharpen and straighten the otherwise rippled and serrated edge.

Prismatic Blade on Conical Core

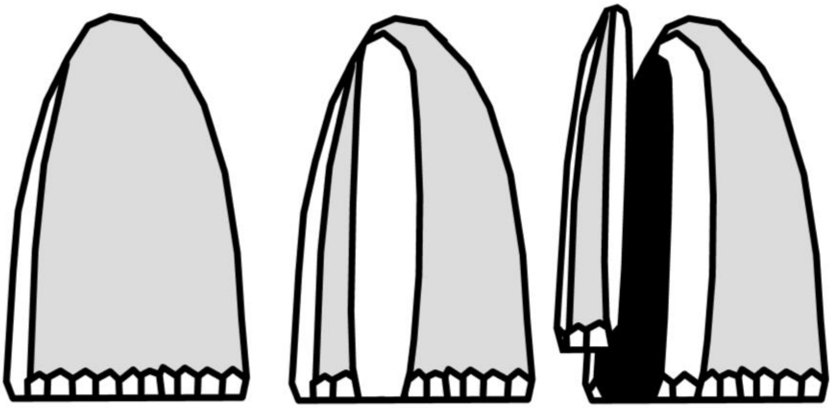
Flakes: 3 – 100’s

Difficulty: Expert

To begin, find an elongated nodule and knock off the more rounded end to reveal a flat, cortex-free surface. Dull the edge of the circumference and remove overhangs (a process which should be repeated after removing each flake).



Removing the first long flake after abrading.



Above: Sequence of flake removal to produce a prismatic blade with a trapezoidal (4-sided) cross-section. After the final step depicted, another trapezoidal blade can be obtained by centering the next strike on the white flake scar. A triangular (3-sided) blade could be obtained by straking *__between__* the white and black scars.
wefw

This detailed but concise little guide introduces new knappers to percussion flaking and the reproduction of the most iconic stone tools of the Paleolithic: the chopper, handaxe, Levallois flake, bifacial knife and prismatic blade.

While there are many knapping tutorials available, many of these focus on manufacturing aesthetic projectile points and non-functional art pieces using sawn slabs, heat treating, pressure flakers and copper billets (hammers) that were not available to our earliest ancestors. On the other hand, while academic literature focuses on utilitarian stone tools and techniques, these are often shrouded in technical terminology and abstract geometry. In this manual, an attempt has been made to avoid this kind of language in favor of easily-understood descriptions and diagrams with a focus on the production of basic functional tools.